Write your name here

Surname	Other names

Pearson BTEC Level 3 Nationals Certificate

Centre Number

Learner Registration Number

Applied Science

Unit 1: Principles and Applications of Science I

Tuesday 23 January 2018 – Morning
Time: 2 hours

Paper Reference
31617H

You must have:
Calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and learner registration number.
- Answer **all** questions.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You must attempt **all** three sections but you may complete them in any order.

Information

- The total mark for this paper is 90.
- The paper is comprised of three sections worth 30 marks each.
  Section A: Structure and functions of cells and tissues (Biology). Starts on page 2
  Section B: Periodicity and properties of elements (Chemistry). Starts on page 10
  Section C: Waves in communication (Physics). Starts on page 18
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- The periodic table of elements and formulae sheet can be found at the back of this paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Applied Science

Unit 1: Principles and Applications of Science I

Biology
SECTION A: STRUCTURE AND FUNCTIONS OF CELLS AND TISSUES

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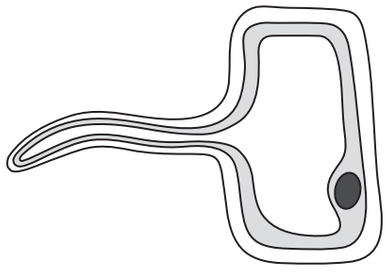
Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then put a cross in another box ☒.

SECTION A – STRUCTURE AND FUNCTIONS OF CELLS AND TISSUES

1 The diagram shows a plant root hair cell.



(a) The plant root hair cell has a large surface area.
The large surface area increases the rate of absorption of water and ions from the soil.

State **two** other ways the structure of the plant root hair cell supports the absorption of water and ions from the soil.

(2)

1 .....

.....

2 .....

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(b) Explain why plant root hair cells do not contain chloroplasts.

(2)

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(Total for Question 1 = 4 marks)

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2 Rough endoplasmic reticulum (rough ER) and smooth endoplasmic reticulum (smooth ER) are organelles found in eukaryotic cells.

(a) State **one** structural difference between rough ER and smooth ER.

(1)

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.....

(b) Give **two** functions of rough ER.

(2)

1 .....

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2 .....

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(Total for Question 2 = 3 marks)

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3 The lungs are organs in the human respiratory system.

(a) State what is meant by the term **organ**.

(2)

(b) Goblet cells are specialised to help protect the lungs.

Explain how goblet cells protect the lungs.

(2)

(c) Emphysema is a chronic obstructive pulmonary disease (COPD) of the lungs.

Describe how damage to the alveoli in the lungs leads to emphysema.

(4)

(Total for Question 3 = 8 marks)

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4 The width of a sperm cell head was measured as 4 μm.

The width of an egg cell was measured as 0.1 mm.

(a) Calculate how many times larger the egg cell is compared to the sperm cell head.

Show your working.

(2)

.....

(b) The egg cell contains large amounts of mitochondria.

Explain why an egg cell contains large amounts of mitochondria.

(2)

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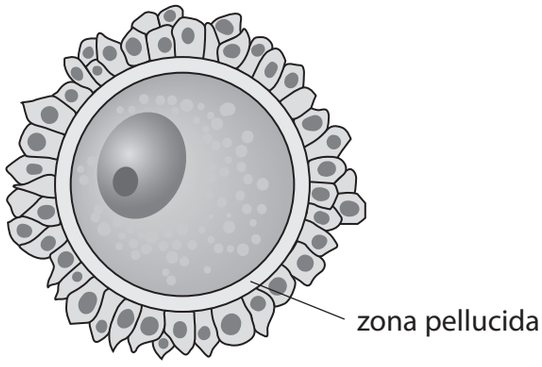
(c) The diagram shows an egg cell.



Explain what happens to the zona pellucida after the egg cell is fertilised.

(2)

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(Total for Question 4 = 6 marks)

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5 (a) Explain the role of myelin in the conduction of nerve impulses in myelinated axons.

(2)

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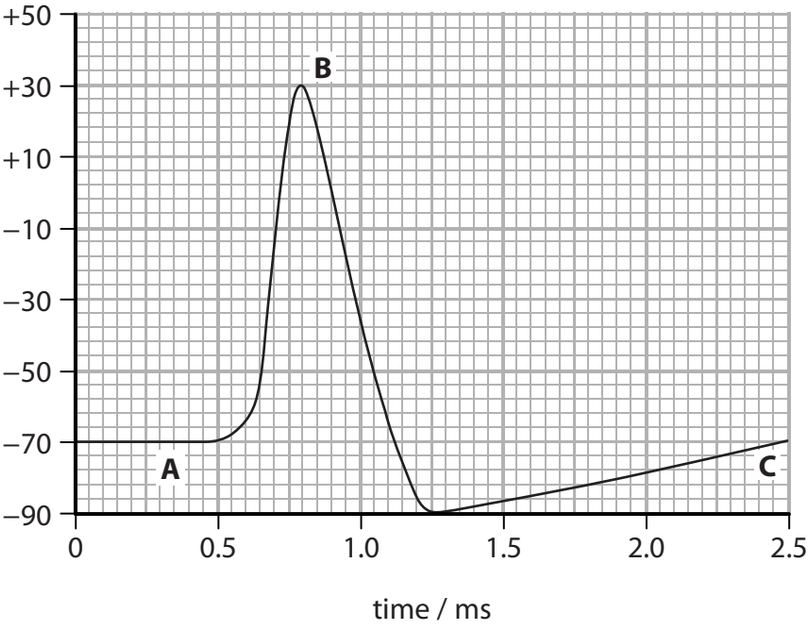
(b) The graph shows an action potential in an axon.



Give the change in membrane potential between point A and point B.

(1)

..... mV

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(c) Explain the changes in membrane potential between points A, B and C on the graph, with reference to changes in membrane permeability of:

- sodium ions
- potassium ions.

(6)

(Total for Question 5 = 9 marks)

TOTAL FOR SECTION A = 30 MARKS

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Unit 1: Principles and Applications of Science I

Chemistry
SECTION B: PERIODICITY AND PROPERTIES OF ELEMENTS

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SECTION B – PERIODICITY AND PROPERTIES OF ELEMENTS

6 Connectors in some electrical circuits are coated in gold.

One property of gold is its ability to conduct electricity.

(a) Give **one** other property of gold that makes it suitable as a connector.

(1)

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(b) Explain how gold conducts electricity.

(3)

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(Total for Question 6 = 4 marks)

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7 The table shows some data about three compounds.

compound	formula	relative molecular mass	boiling point (°C)
water	H_2O	18	100
methanol	CH_3OH	32	65
ethanol	C_2H_5OH		79

(a) Calculate the relative molecular mass for ethanol.

Show your working.

(2)

Relative molecular mass = ...

(b) Explain, in terms of intermolecular forces, the differences in the boiling points of the three compounds.

(4)

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(Total for Question 7 = 6 marks)

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8 (a) Silver bromide, AgBr, is an important chemical in the manufacture of photographic film.

Potassium bromide reacts with silver nitrate, $AgNO_3$, to form silver bromide.

Write the balanced equation for the reaction of potassium bromide with silver nitrate.

(2)

.....

(b) Silver bromide and potassium bromide both contain strong ionic bonds.

State what is meant by the term **ionic bond**.

(1)

.....

.....

(c) Potassium iodide, KI, is another ionic compound.

(i) Draw a dot and cross diagram to show the bonding in **potassium iodide**.

Show the outer electrons only.

(3)

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(ii) Potassium iodide is soluble in water.

A student dissolves 16.6 g of potassium iodide in distilled water and makes the volume of the solution up to 500 cm^3.

Calculate the molar concentration of the solution produced.

(relative formula mass of potassium iodide = 166)

Show your working.

(4)

Concentration = ... $mol\,dm^{-3}$

(Total for Question 8 = 10 marks)

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9 (a) The electronic configuration of an element is

$$1s^2\ 2s^2\ 2p^2$$

Identify the group of the periodic table that contains this element.

(1)

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

(b) (i) Write an equation to show the first electron affinity of oxygen to produce the oxygen ion, O^-.

(2)

.....

(ii) Complete the electronic configuration for an oxygen ion, O^-.

(1)

1s..... 2s..... 2p.....

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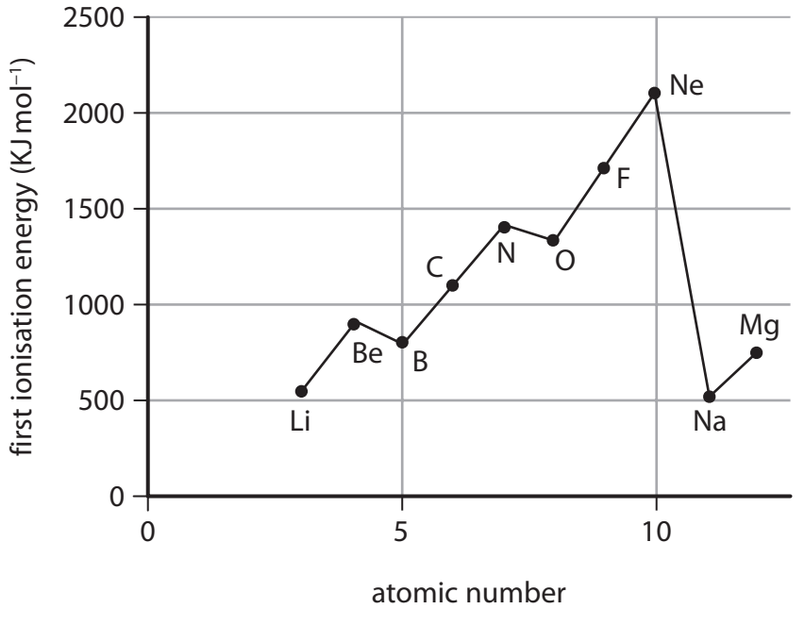
(c) The graph shows the first ionisation energies of the elements lithium to magnesium.



Explain the trends in first ionisation energy from lithium to magnesium, with reference to:

- energy levels
- s and p orbitals.

(6)

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(Total for Question 9 = 10 marks)

TOTAL FOR SECTION B = 30 MARKS

Applied Science

Unit 1: Principles and Applications of Science I

Physics
SECTION C: WAVES IN COMMUNICATION

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SECTION C – WAVES IN COMMUNICATION

10 (a) Identify the region of the electromagnetic spectrum with the lowest frequency.

(1)

☒ **A** microwaves

☒ **B** radio waves

☒ **C** ultraviolet waves

☒ **D** visible waves

(b) (i) Explain **one** advantage of using microwave radiation in mobile phone communications.

(2)

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(ii) Explain **one** disadvantage of using microwave radiation in mobile phone communications.

(2)

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(Total for Question 10 = 5 marks)

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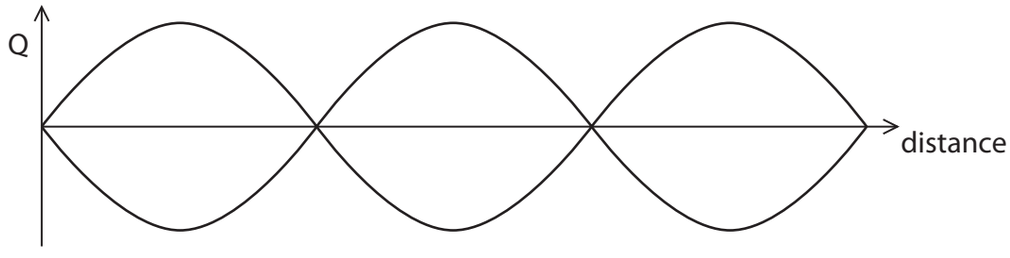
11 (a) The picture shows a guitar.

A standing wave is produced when a guitar string is plucked.

The standing wave is represented on the graph.



(i) Give the missing label, Q, for the y-axis on the graph.

(1)

(ii) Label with the letter N the position of **one** node, on the graph.

(1)

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(b) A guitar string is tuned by changing the tension.

The speed of a wave in the string is 16.2 m s^{-1}.

The mass per unit length of the string is 0.3 kg m^{-1}.

Calculate the tension in the string.

Show your working.

(4)

Tension = ... N

(Total for Question 11 = 6 marks)

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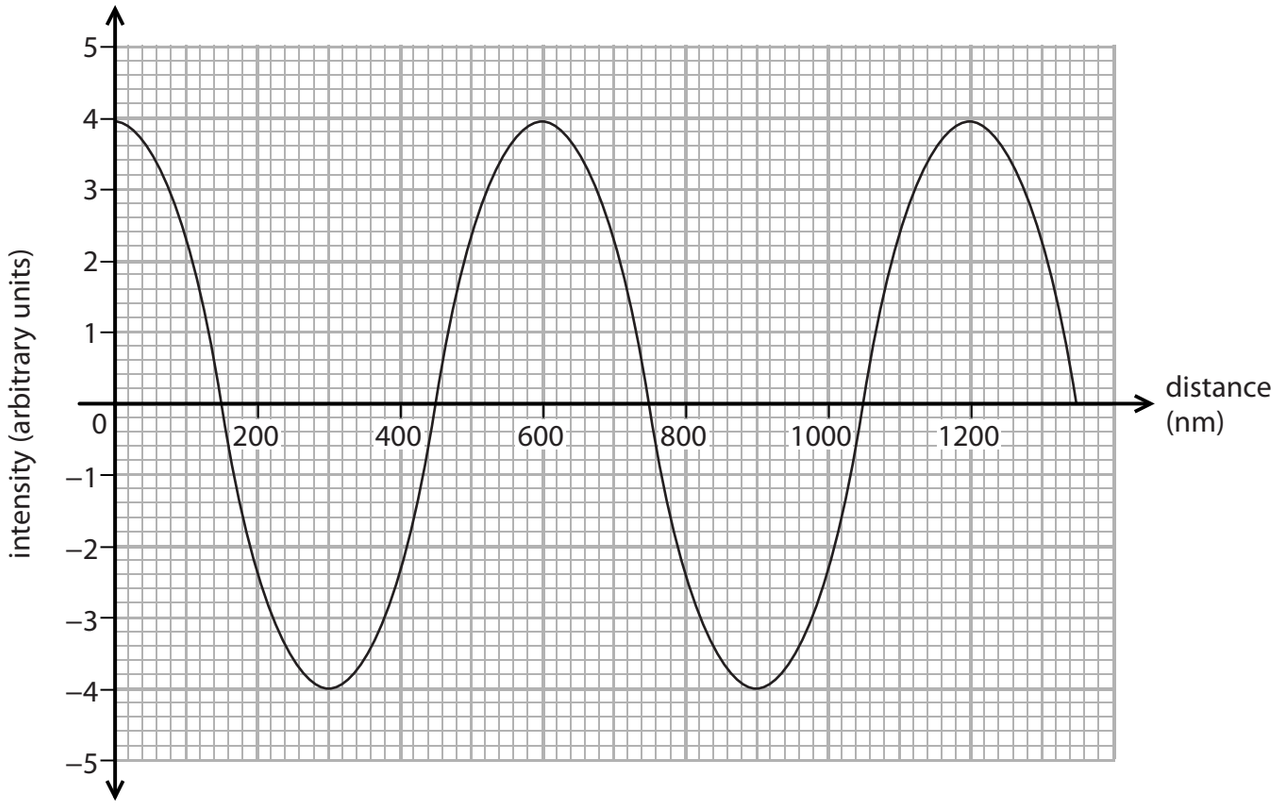
12 Diffraction gratings allow light waves to be split into beams that travel in different directions.

(a) The graph shows a representation of a light wave.



Give the wavelength of the light wave in the graph.

(1)

..... nm

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(b) A diffraction grating is used to analyse sunlight.

The pattern produced has a bright central white line.

On either side of the white line there are bands of different colours.

The bands of different colours become increasingly blurred the further away they are from the central white line.

(i) Explain why the central white line is bright.

(2)

(ii) Explain why the diffraction grating produces a pattern of coloured bands.

(4)

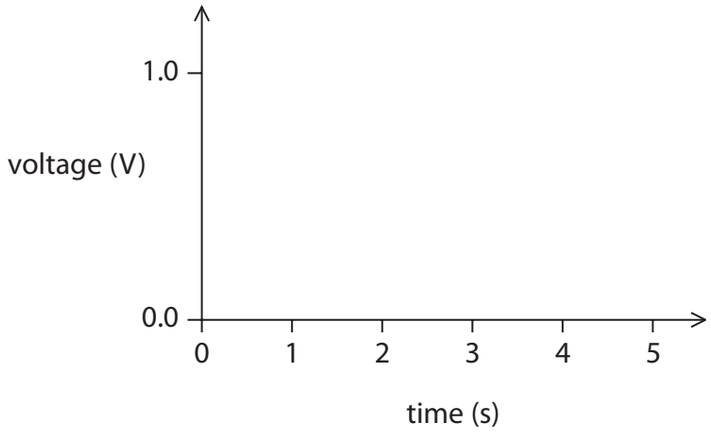
(Total for Question 12 = 7 marks)

13 A digital signal has a value of 1.0 V when it is on and 0.0 V when it is off.

The digital signal changes every second.

(a) Draw a digital signal corresponding to 1 0 1 0

(2)



(b) Which of these processes occurs in an analogue-to-digital converter?

(1)

☒ **A** displaying data

☒ **B** randomising data

☒ **C** sampling data

☒ **D** storing data

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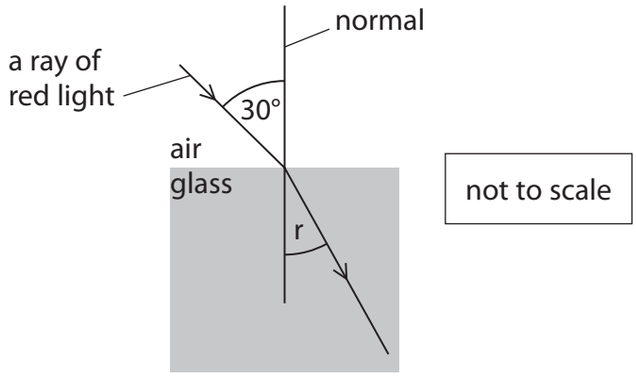
(c) An optical fibre is made of glass.

The speed of red light in air is $3.0 \times 10^8\,m\,s^{-1}$.

The speed of red light in the glass is $2.0 \times 10^8\,m\,s^{-1}$.

A ray of red light enters the glass from the air with an angle of incidence of 30°.



not to scale

Calculate the angle of refraction, r, of the red light in the glass.

Show your working.

(3)

Angle of refraction = ... °

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(d) Explain the strengths and weaknesses of using optical fibres to supply broadband to homes.

(6)

(Total for Question 13 = 12 marks)

TOTAL FOR SECTION C = 30 MARKS
TOTAL FOR PAPER = 90 MARKS

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Formulae sheet

Wave speed $v = f\lambda$

Speed of a transverse wave on a string $v = \sqrt{\frac{T}{\mu}}$

Refractive index $n = \frac{c}{v} = \frac{\sin i}{\sin r}$

Critical angle $\sin C = \frac{1}{n}$

Inverse square law in relation to the intensity of a wave $I = \frac{k}{r^2}$

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
																	(18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)											(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4											10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	58.9 Co cobalt 27	58.7 Ni nickel 28	63.5 Cu copper 29	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	79.0 Se selenium 34	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	91.2 Zr zirconium 40	92.9 Nb niobium 41	95.9 Mo molybdenum 42	[98] Tc technetium 43	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	106.4 Pd palladium 46	107.9 Ag silver 47	112.4 Cd cadmium 48	114.8 In indium 49	118.7 Sn tin 50	121.8 Sb antimony 51	127.6 Te tellurium 52	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	178.5 Hf hafnium 72	180.9 Ta tantalum 73	183.8 W tungsten 74	186.2 Re rhenium 75	190.2 Os osmium 76	192.2 Ir iridium 77	195.1 Pt platinum 78	197.0 Au gold 79	200.6 Hg mercury 80	204.4 Tl thallium 81	207.2 Pb lead 82	209.0 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[262] Db dubnium 105	[266] Sg seaborgium 106	[264] Bh bohrium 107	[277] Hs hassium 108	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[272] Rg roentgenium 111							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	[147] Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	163 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
* Actinide series	232 Th thorium 90	[231] Pa protactinium 91	238 U uranium 92	[237] Np neptunium 93	[242] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[245] Bk berkelium 97	[251] Cf californium 98	[254] Es einsteinium 99	[253] Fm fermium 100	[256] Md mendelevium 101	[254] No nobelium 102	[257] Lr lawrencium 103

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